## RESEARCH SEMINAR OF THE MARINE BIOLOGICAL LABORATORY.

### I. ZOÖLOGY, SEASON OF 1904.

*July 5.* **Work on the Life Histories of some Cestode Parasites of Fishes.** By WINTERTON C. CURTIS.

*July 8.* **Conditions that Determine the Relative Position of Chromosomes in Mitosis.** By RALPH S. LILLIE.

*July 12.* **The Physiology of the Invertebrate Heart.** By A. J. CARLSON.

The following points were demonstrated by drawings and graphic records:

1. With the exception of *Mytilus*, in which the results are not conclusive, the auricles and the ventricle of the lamellibranchs (*Mya*, *Tapes*, *Venus*, *Hennites*, *Pecten*, *Cardium*) are supplied with inhibitory nerves from the visceral ganglion or ganglia. These fibers reach the heart in the renal nerves and enter at the base of the auricles. No nerves enter the heart along the aortæ or the rectum.

The heart of the prosobranchs (*Haliotis*, *Lucapina*, *Natica*, *Sycotypus*) and the tectibranchs (*Aplysia*, *Bulla*, *Pleurobranchæa*) is supplied with accelerator nerves from the visceral ganglion or ganglia. These nerves enter the ventricle at the aortic end. Some fibres may also reach the ventricle through the auricular walls. The auricular nerves enter the auricle at its base.

The heart of the nudibranchs is supplied with regulative nerves from the brain or supraœsophageal ganglion. In *Montereina* these nerves appear to be of the accelerator type only, while in *Triopha* both inhibitory and accelerator nerves are present.

The auricle of the slugs (*Limax*, *Ariolimax*) and the snail (*Helix*) is supplied with both inhibitory and accelerator nerves from the subœsophageal or pleural ganglion. These nerves enter the auricular musculature at the base of the auricle. The innervation of the ventricle of these pulmonates appears to be less uniform. The ventricle of *Helix* is supplied with both in-

hibitory and accelerator fibres from the same nerve as the auricle. These fibers enter the ventricle at the aortic end, some fibers reach the ventricle also through the walls of the auricle. The ventricle of *Limax* appears to be supplied with inhibitory nerves only, which enter it through the auricular walls. The ventricle of *Ariolimax* is supplied with accelerator, and probably also inhibitory fibres from the same source as the auricle. The fibres enter the ventricle at the aortic end. In *Helix* the influence of the inhibitory fibres on the ventricle, in *Ariolimax* that of the accelerator, is the greatest.

The systemic and the gill hearts of the cephalopods (*Octopus*, *Loligo*, *Ommastrephes*) are supplied with inhibitory fibres from the visceral nerves, and there is some evidence that accelerator fibres reach these hearts from the same source. In the squid the fibres to the systemic ventricle and to the auricles leave the visceral nerves at different levels. The rhythmically contracting parts of the renal veins are probably supplied with inhibitory fibres from the visceral nerves. The visceral nerves also send fibres to the pulsating vena cava. Their function was not made out.

The heart of crustaceans is supplied with inhibitory and accelerator fibres from the thoracic ganglion. In *Palinurus* the inhibitory and the accelerator fibres reach the heart along two separate pairs of nerves.

The heart of *Limulus* is supplied with inhibitory nerves from the posterior end of the brain or pericœsophageal ganglion, and with accelerator nerves from the abdominal ganglia. These nerves enter the nerve-cord on the dorsal side of the heart. There is some evidence that the heart of spiders and insects is supplied with inhibitory nerves from the brain or the thoracic ganglia.

2. The action of the inhibitory nerves on the invertebrate heart is the same as the action of the vagus fibers on the vertebrate heart. The accelerator nerves in the molluscs produce contractions in the quiescent heart. Single induced shocks applied to the cardiac nerves are usually without influence on the heart unless of considerable intensity.

3. The latent period of the heart-muscle is less than 0.03″ in

the lamellibranchs and the gasteropods; in the cephalopods it does not exceed 0.02″; in the crustaceans it does not exceed 0.01″. The latent period of the heart-muscle is not greater than that of the body-muscle of the same animal.

4. The rate of propagation of the contraction in the tunicate heart (*Ciona*) varies from 200 to 350 mm. per sec.

5. The molluscan, the arthropod, and the tunicate heart exhibits a condition of reduced excitability at the beginning of systole, but no refractory period in the sense of inexcitability.

6. The molluscan, the arthropod, and the tunicate heart, that is greatly fatigued or injured, and in poor condition so that it does not beat spontaneously, responds to stimuli of increasing intensity with contractions of increasing amplitude; but the pulsating heart or the quiescent heart whose excitability is not greatly reduced tends to respond with contractions of uniform amplitude to stimuli of increasing intensity within a wide range, but increasing the strength of the stimulus above this range is followed by supermaximal contractions. The "all-or-none" law does not apply.

7. In the molluscan and the crustacean heart a strong induced shock sent through the heart at the beginning of systole diminishes the strength of that beat.

8. The molluscan, the arthropod, and the tunicate heart is inhibited in diastole by the interrupted current of a certain intensity applied directly to the heart. This inhibition is obtained in hearts apparently not provided with inhibitory nerves, and in hearts provided with inhibitory nerves after these have been paralyzed by the action of drugs. It is therefore an action of the induced current directly on the rhythmical tissue.

9. The molluscan, the arthropod, and the tunicate heart can be tetanized.

*July 15.* **Feeding Experiments for Determining the Life History of an Oyster Parasite.** By D. H. TENNENT.

The experiments described were conducted for the purpose of determining the adult form and the life history of the trematode, of which *Bucephalus haimeanus* Lacaze Duthiers (*Bucephalus cucullus* McCrady), abundant in oysters of various regions, is the cercaria.

An account of the varying degrees of infection, from that of the presence, in the visceral mass, of a simple unbranched sporocyst, to the almost complete replacement of the gonads and liver by the long germ tubes, or branches of the sporocyst, was first given.

The first experiments described were conducted for the purpose of determining whether infection might spread directly from one oyster to another. Five experiments covering about one year, were mentioned.

In the second experiments conducted, an attempt was made to obtain the adult form by feeding infected oysters to fish which were kept in aquaria. These experiments seemed to show conclusively that the host of the adult form of *Bucephalus* was not necessarily an oyster-eating fish.

While these experiments were being carried on, a search for *Gasterostomum*, to which *Bucephalus*, by reason of its structure, would seem to be intimately related, was being made. The animals and plants found in the regions in which infected oysters occur, were thoroughly examined.

*Gasterostomum* was ultimately found in abundance in the garfish, *Tylosurus marinus*.

After determining the food of the gar, collections of the various fish and crustacea included in this list were examined.

In the viscera of the silverside, *Menidia notata*, specimens of which had been found in the stomach of the gar, encysted forms, little different in appearance from the cercariæ present in the oyster, were obtained.

The final set of experiments consisted in feeding viscera of the silverside to four species of fish, previous examinations having shown that in these species *Gasterostomum* does not occur.

These experiments showed that the encysted forms from the silverside were able to resist the action of the digestive juices of the fish to which they were fed and that they attached themselves to the wall of the intestine of their new host and continued in their development.

The evidence afforded by these experiments and observations showed that during its life history *Gasterostomum*, parasitic in the digestive tract of *Tylosurus marinus*, passes its cercaria stage

(*Bucephalus haimeanus*) in the oyster; that the cercariæ becoming mature leave the oyster and swim about in the water; that they are from thence obtained as food by the silverside and other small fish; that in these fish they encyst, finally to be released, and become sexually mature when their hosts are eaten by *Tylosurus*.

The extent of infection, the character of the regions in which infected oysters are found, the effect of the parasite upon the oyster, the origin of the germ cells from which the cercariæ arise and the significance of the differences in appearance and rate of growth in the experiment fish were also mentioned.

The experiments described were conducted at the Beaufort, N. C., Fisheries Laboratory.

*July 19.* **Relation of Ants to Temperature and Submergence.** By ADELE M. FIELD.

An artificial nest was made, having as its basis a half-cylinder of copper, with ends projecting beyond the nest. One end of the copper was heated by an alcohol flame, while the other end was surrounded by ice. Different parts of the nest presented diverse temperatures, ranging from 10° C. or 14° F. to 60° C. or 140° F. Ants of various species were introduced into this nest, and it was found that the temperature preferred by them was from 24° C. or 76° F. to 27° C. or 82° F. Below 15° C. or 60° F. the ants become sluggish, and increase of temperature was accompained by increase of activity. Above 30° C. or 86° F. they manifested discomfort or distress. Exposure to heat so great as 50° C. or 122° F. for a period of fifteen seconds for the smaller ants, or of two minutes for the larger ants, invariably killed them, probably by coagulation of their protoplasm. The effect was the same whether the heat was applied through a wet or dry medium.

Ants of the same species as those killed by heat, survived submergence in cool water for seventy-two hours. The futility of ploughing up ant-nests with the expectation that the spring rains would destroy the ants was alluded to, and the application of heat was suggested as a better means of destroying these pests on farms.

*July 22.* **Habits and Life-History of Parasitic Copepods.** By CHARLES B. WILSON.

A statement was first made of some of the problems confronting the student of this group, for only one of which has there been any attempt at solution. This is the one which logically comes first, the determination and description of species. But it is the least important and should be quickly followed by a careful study of habits, including relative abundance and the influence of the parasite upon its host. The life-history must also be worked out before adequate methods can be devised for exterminating the parasites or checking their ravages. Then come a series of ecological problems for which these copepods afford exceptionally fine material, color protection, mimicry, adaptation to environment, degeneration phenomena, and the like.

Material was shown for several of these problems, with a series of drawings for the life-history of the Caligidæ, the largest family in the group. The history of three members of this family, *Caligus rapax*, *Caligus bonito* and *Alebion glabrum*, was presented in full, that of others only partially.

The eggs hatch into a typical nauplius which swims about freely at the surface. After the second or third moult it becomes a metanauplius whose second antennæ cease to function as locomotor and become prehensile. At this stage it seeks its host and fastens to it.

In *Caligus*, *Lepeophtheirus* and allied genera an attachment filament is developed at the next moult from a median frontal gland which holds the larva securely to its host until it has matured. In *Alebion* and allied genera the second antennæ continue to serve as organs of attachment up to maturity. In the metanauplius there are but two pairs of thoracic appendages; a pair is added at each successive moult up to the normal number.

These parasites do not usually injure their host, but may become sufficiently numerous to cause serious damage, especially if the host has been weakened or injured.

They feed upon the blood of their host which they obtain by piercing the skin in the vicinity of blood vessels and extracting the blood by means of a suctorial mouth tube.

They often become a serious nuisance to the artificial breeder

of fish in ponds or aquaria. The only remedy in the case of the adults is to remove them carefully from the fish, but further trouble can be avoided by a plentiful introduction of small surface fish, sticklebacks, minnows, etc., which will eat up the larvæ of the parasitic copepods.

*July 26.* **The Nature of the Heart-Rhythm.** By A. J. CARLSON.

The following points were demonstrated on the heart of *Limulus*.

1. The heart-beat is neurogenic, not myogenic. The heart-muscle is not automatic under the normal conditions of life. Extirpation of the ganglion or nerve-cord on the dorsal side of the heart abolishes the rhythm at once and permanently, the muscle contracting only on artificial stimulation.

2. Coördination or conduction in the heart takes place in the nervous and not in the muscular tissue. The entire heart, save the median nerve-cord and the lateral nerves, may be cut transversely. This does not affect conduction or coördination. Severing the nerve-cord and the lateral nerves, leaving the heart-muscle intact, abolishes coördination of the ends of the heart at either side of the lesion, the contraction not passing the level of the lesion in either direction.

3. The inhibitory nerve-fibers act on the ganglion cells in the heart and not on the heart-muscle. Cardiac inhibition falls within the category of inhibition of automatic or reflex neural processes.

*August 2.* **Toxic and Antitoxic Action of Salts.** By ALBERT P. MATTHEWS.

*August 6.* **Causes of Blue and Green in Feathers.** By R. M. STRONG.

There are no blue pigments known in feathers, excepting one possible case cited by Häcker, and green feathers rarely owe their colors to green pigments. The blues are so-called structural colors confined to the barbs, usually.

Walter's hypothesis that these phenomena are *surface* colors produced by underlying melanin pigments is untenable because the pigments when isolated are not blue but dark brown.

There are serious objections to the turbid medium hypothesis of Häcker and others. Experimental studies indicate that most

of the blue is produced, not in the horn substance of the feather, but at the dorsal inner surfaces of medullary cells where the incident light passes from the horn substance into the air filling the cavities of the medullary cells. The blue color is probably due to the stronger refraction of the blue end of the spectrum with consequent greater reflection of the blue.

The greens are usually produced by feathers which do not differ essentially from blue feathers except in having a yellow pigment in the cortex. The yellow pigment absorbs the incident blue, but transmits the green rays. The latter are reflected more strongly than the rays on the red side of the green in the spectrum, and they consequently give the feather its green color.

Many variations occur in the shape of blue and green barbs, and the latter very commonly have a high elevation of the dorsal cortex which contains a diffuse yellow pigment. The barbules are usually reduced or absent.

In some species, we find the green changing to dark dull yellow when the angle of incidence becomes very large. This phenomenon does not belong to the category of the common metallic or iridescent colors. It depends on purely mechanical conditions. The green disappears when the angle of incidence becomes so great that only the dorsal, yellow cortical elevations of the barbs are in view.

*August 9.* **Rheotropism in Fishes.** By E. P. LYON.

It seemed impossible to the author that pressure could be the method of stimulation which brought about orientation of fishes in a current of water, according to the usual theories on the subject. The effect of the current would seem to be simply to carry organisms having approximately the same specific gravity as water down stream. No pressure would result unless the animal became oriented and swam against the current. It therefore seemed that points of reference on the bottom or banks must be as important in stimulating the fish as the current itself. Testing this hypothesis it was found that the fish responded to any movement of the bottom of the dish in which they were kept, turning in the same direction as the moving objects. By a series of experiments it was definitely made out that by far the largest ele-

ment in securing orientation of the fishes experimented with is an optical reflex of such a kind that the animal tends to retain the same visual field. It is found however that blind fishes or fishes in the dark are able to orient themselves. Investigation of this phenomenon showed that it is primarily due to objects on the bottom. Blind fishes do not orient themselves in a uniform current unless they touch objects which are stationary. In more violent streams of water where there are considerable differences of velocity between closely proximated parts of the stream, orientation may occur. Here apparently the same explanation holds, *i. e.*, that the relatively stationary water constitutes the reference points by which the animal establishes its direction in the stream.

It is believed that pressure in a gross, mechanical way cannot explain rheotropism, but rather that it is always a response to the relative motion between the fish being carried passively down by the moving water, and more stationary parts of the environment.

*August 12.* **Osmotic Pressure of Sea Water and Marine Animals.** By W. E. GARREY.

1. The osmotic pressure of the sea water was determined by testing the depression of the freezing point ($\Delta$) with a Beckmann apparatus.

(*a*) Buzzards Bay water, $\Delta = -1.83°$ and $-1.82°$.

(*b*) Eel Pond water, $\Delta = -1.77°$.

(*c*) Salt water tap of Marine Biological Laboratory showed considerable variations; $\Delta = -1.86°$ in the early part of the season and as low as $-1.78°$ after heavy rains. Most of the readings however varied between $-1.84°$ and $-1.82°$.

(*d*) Basin of Fish Commission $-1.84°$ and $-1.81°$.

These waters thus show a freezing point slightly less than that of molecular cane sugar ($\Delta = -1.85°$) and the osmotic pressure is about 22 atmospheres calculated at 0° C.

2. The body fluids of marine invertebrates have an osmotic pressure very close to that of the sea water from which they are taken.

3. By immersion in diluted or concentrated sea water marine invertebrates take up or lose water respectively and assume an osmotic pressure approximating that of the external medium.

4. Selachians have an osmotic pressure equal to that of the sea water and change with the external medium, although not so readily or completely as invertebrates. They die if the change in osmotic pressure is great.

5. Marine teleosts have an osmotic pressure only about half that of the sea water; $\Delta = -0.80°$ and $-0.96°$. Transferring common eels from salt into fresh water did not lower the osmotic pressure of their blood. *Fundulus Heteroclitus* could also be placed in fresh water or doubly concentrated sea water and live for weeks. If, however, the body was partly scaled, or part of the skin removed, the fish die in normal sea water and in fresh water, but can be kept indefinitely in sea water which has been diluted with an equal volume of distilled water and which therefore has an osmotic pressure approximating that of their blood. These experiments point to the normal impermeability of the teleost integument.

*August 12.* **Coagulation of the Blood.** By LEO LOEB.

In former investigations I made it very probable that the so-called first coagulation of the blood of certain arthropods and the coagulation of the blood of *Limulus* consists in an agglutination of blood cells, that in the second coagulation of arthropods, on the other hand, fibrin is formed from fibrinogen under the influence of substances present in the blood cells and in the tissues. The latter, which I called tissue coagulins, are, within certain limits, specific, the former being not at all or much less specific. Similar conditions are present in vertebrate blood.

We have therefore to distinguish between two kinds of substances which may, under ordinary circumstances, affect the coagulation of the blood, namely, substances present in the serum and those present in the tissues (tissue coagulins).

Quite recently several investigators (Morawitz, Fuld u. Spiro) have advanced the theory that the tissue coagulins act only indirectly by transforming (to use the terms of Morawitz) thrombogen into prothrombin, which, by the aid of calcium, becomes the active ferment. This is a somewhat modified form of Alexander Schmidt's theory of the coagulation of the blood. Certain facts, however, made it appear to me more probable that

the tissue coagulins attack the fibrinogen directly and transform it into fibrin. That this actually does take place I believe to have been able to show in the invertebrate blood (lobster), insofar as tissue coagulins still cause the coagulation of the blood plasma, after the substances present in the blood which accelerate the coagulation of the blood have been previously destroyed by heat.

It seems permissible to apply this result to vertebrate blood, the similarity between the factors causing the coagulation of vertebrate and invertebrate blood being very great.

In connection with the foregoing experiments a comparative study of the conditions under which these two substances act was made (influence of dilution, of calcium and other salts, power of resistance, preparation of active extracts). Their action on artificially prepared fibrinogen was also compared.

New facts were found which support the view formerly expressed that the coagulation of other arthropods represents an agglutination of the blood cells. In accordance with this view, I could prepare fibrinogen from lobster blood, in which a second coagulation takes place. On the other side, no fibrinogen could be prepared from *Limulus* blood, which has no second coagulation.

### 2. Botanical Lectures and Seminars in 1903.

July 8, Dr. George T. Moore: "The Polution of Public Water Supply by Algæ."

July 10, Dr. Bradley M. Davis: "The Relationships of the Sexual Organs of Plants."

July 20, Dr. Henry Kraemer: "The Unorganized Contents of the Plant Cell."

July 21, Dr. Henry Kraemer: "The Structure of the Cell Wall."

July 27, Mr. Herbert J. Webber: "History and General Factors of Plant Breeding."

July 28, Mr. Herbert J. Webber: "The Principles of Selection and Isolation in Improving Breeds."

July 29, Mr. Herbert J. Webber: "The Mutation Theory of De Vries."

July 30, Mr. Herbert J. Webber: "The General Laws of Hybrids with a Discussion of Mendel's Principles."

July 31. Mr. Herbert J. Webber: "The Utilization of Hybrids in Practical Plant Breeding and the Selection of Vegetative Parts in Breeding."

August 5, Dr. Bradley M. Davis: "Cytoplasmic Structures of the Plant Cell."

August 6, Dr. Rodney H. True: "Theory of the Nature of Solutions. Dissociation Hypothesis and Objections to it."

August 7, Dr. Rodney H. True: "Toxic Action of Solutions on Plants, caused by Solutions Containing One Solute."

August 10, Dr. Rodney H. True: "Toxic Action of Solutions on Plants Caused by Solutions containing more than one Solute."

August 11, Dr. Rodney H. True: "Influence of Solutions on Plant Functions and Structure."

August 11, Mr. Christopher S. Oglevee: "The Influence of Insoluble Substances on the Action of Poisons in Solutions."

August 12, Dr. Rodney H. True: "Artificial Sea Water."

*July 8.* **The Pollution of Public Water Supplies by Algæ.** By GEORGE T. MOORE.

The importance of a scientific investigation of this most common cause of the bad odors and tastes in drinking water was pointed out and numerous examples were given of the serious inconvenienee and great financial loss due to the presence of algæ in reservoirs. It is necessary to recognize that the means of finding a remedy for the trouble must be biological rather than chemical or mechanical, and it is only after we are familiar with the life history of the organisms producing the odor and taste that we can hope to find a remedy.

Certain experiments then under way, being carried on by the Department of Agriculture, were described, and it was believed that the result of these trials would prove the discovery of a cheap and practical remedy which could be used on the largest scale and yet not cause trouble to the consumer.

*July 10.* **The Relationships of the Sexual Organs of Plants.** By BRADLEY MOORE DAVIS.

The types of sexual organs found in plants, their structure, origin and relationships were considered. These types fall into

three classes: (1) the unicellular sexual organs (gametocysts) (2) the multicellular sexual organs (gametangia) and (3) the peculiar multinucleate gametocysts which become sexual cells (cœnogametes). The first class (gametocysts) is found throughout the Thallophytes, and the evolutionary principles governing their differentiation into spermatocysts and oöcysts are well understood. The second class (gametangia) is characteristic of the bryophytes and pteridophytes and contains the well-known antheridium and archegonium of these groups. The possible origin of these structures from the plurilocular sporangium, according to the writer's recently published hypothesis, was discussed. The third class (cœnogametes) comprises the remarkable cœnocytic sexual cells found among the Mucorales, Saprolegniales and Peronosporales. Great interest attaches to their behavior and phylogenetic relations on account of the peculiarities of their structure, which are not found in any other group of organisms. The author's explanation of these conditions was presented in the light of his recent investigations on oögenesis in *Vaucheria*.

*July 20.* **The Unorganized Contents of the Plant Cell.** By HENRY KRAEMER.

The micro-chemical and micro-physical properties of the following unorganized cell contents were considered: (1) Product of constructive metabolism; the crystalloidal carbohydrate, starch. (2) Products of reconstructive or destructive metabolism; *A*, organic substances — (*a*) occurring in the protoplasm and cell-sap, as oils, resins, ferments and proteine crystalloids; (*b*) occurring in the cell-sap, as crystalline carbohydrates (dextrose, maltose, sucrose, etc.) and the crystalloidal carbohydrate inulin; (*c*) occurring in cell-sap or cell-wall, colloidal carbohydrates (gums, mucilages and pectins), tannin, alkaloids, glucosides and calcium oxalate; *B*, inorganic substances — (*a*) calcium carbonate in cystoliths or in the cell-wall; (*b*) silica in irregular masses or in the cell-wall.

*July 21.* **The Structure of the Cell-wall.** By HENRY KRAEMER.

The various methods for differentiating the different lamellæ of the cell-wall were first considered. The similarity in the

structure of the starch grain and that of the cell-wall was demonstrated by micro-physical means, the use of iodine solutions and aniline stains. The various types of cell-walls and modified cell-walls were described as follows: (1) Cellulose walls; (2) ligno-cellulose walls; (3) adipo-cellulose walls; (4) mucilage-cellulose walls; (5) pecto-cellulose walls; (6) reserve-cellulose walls. In connection with the study of the reserve-cellulose walls the work of the author on the continuity of protoplasm was considered, and the similarity of the structure of the walls of this class to the structure of the wheat starch grain was pointed out.

*July 27.* **History and General Factors of Plant Breeding.** By HERBERT J. WEBBER.

This lecture included a discussion of the history of breeding from the time of Fairchild who made the first plant hybrid in 1719 to the present time. The principles of breeding advocated by Knight and Van Mons were compared with later methods and the gradual improvement traced.

Illustrations were given of physiological variations, individual or congenital variations and mutations or saltatory variations, showing how the two latter forms of variations have been utilized by practical breeders, while physiological variations have proven valueless because not hereditary.

The factors of breeding, including the general laws of heredity, transmitting power, unity of individual isolation and selection, were considered briefly.

The speaker emphasized the importance of breeding for a special purpose and with a definite idea in view. The breeder should be familiar with all varieties, races, and species of the plant which he proposes to improve, and select as the parent or parents for his new sort, the existing variety or varieties which exhibit in the greatest perfection the ideal characters which he desires to combine.

In the amelioration of a wild species it has been claimed since the time of Knight that it is first necessary to "break the type" as it is expressed, to get the plant into a condition of variation. It is claimed that a wild plant is for some time very stable and but slightly variable under conditions of cultivation, and that by continuous high cultivation this stability can be broken and the

plant changed into a condition of variability, a condition which would appear comparable to the mutation period predicated by De Vries. The evidence in favor of the theory of breaking the type is slight being based mainly on the experiments of Knight and H. Vilmorin.

*July 28.* **The Principles of Selection and Isolation in Improving Varieties.** By HERBERT J. WEBBER.

This lecture described in detail the methods of selection used in originating new races and strains of wheat, corn, cotton, sugar, beets, and other agricultural crops. The nursery method of planting introduced by Hallett and used extensively in this country by Professor Hays and others was compared with the field method of selection introduced by Rimpau, and illustrations were given of the use of each method in the production of new forms. The nursery method gives to each plant all the space it requires and allows the plant to show what it will do under the most favorable conditions. The field method provides for the growing of the plants under the conditions of field culture where different individuals compete with each other in a struggle for existence, the same as occurs in the ordinary conditions of culture under which the plant is grown.

The importance of considering the individual as the unit of selection under ordinary conditions was emphasized but it was pointed out that in some cases the selection of a fraction of an individual will give quicker results. In corn for instance, the kernels on an ear may show several different colors and it was demonstrated that a uniform color can be secured more quickly by separating out these kernels which show the desired color. In hybrids of smooth and fuzzy-seeded cottons on the same plant, some bolls may have nearly smooth seeds, while others have fuzzy seeds in various degrees. It has been found that the seeds in a single boll run very uniform either smooth or fuzzy, and the evidence obtained on this point indicates that a larger percentage of individuals producing smooth seed can be obtained by selecting seed only from bolls producing smooth seed. These points were emphasized to show that breeders must be prepared to take advantage of every important point that may appear.

*July 29.* **The Mutation Theory of De Vries.** By HERBERT J. WEBBER.

The speaker called attention to the fact that very many of the races and varieties of our cultivated plants have originated as sudden variations. Individual variations were discussed in comparison with mutations and it was claimed that no strict line of demarkation can be drawn between the two. The work of selections deals mainly with slight individual variations, some of which as shown by experiment have strong transmitting power and reproduce themselves true to type in large degree. No means exists of distinguishing between these and small mutations which are mainly transmitted true through the seed. The difference is one of degree only, it was claimed, and cannot be detected with certainity.

The influence of natural selection in the origin of natural species is not eliminated by accepting the idea that variations that form species are produced as mutations. Mutations of all kinds are doubtless formed, desirable and undesirable, fit and unfit, and only those maintain themselves and form permanent species that are fully in harmony with the environment and thus survive. Undesirable mutations are weeded out by natural selection. Even granting the occurrence of a mutation strikingly different from the parent type and thoroughly fitted to the environment, something more is necessary other than natural selection to insure its forming a new species. It is of primary importance that the mutation or variation have strong transmitting power, giving progeny like the parent mutation. Aside from this, some form of isolation is necessary to secure the formation of the new type as the few plants showing the variation would be swamped by panmixia. This swamping the speaker pointed out could be overcome or avoided in at least three ways; namely, (1) geographical isolation, (2) tendency to self-fertility, or prepotency of pollen, (3) a tendency to prepotency or preponderance of type. The first of these, the influence of geographical isolation, has been emphasized by Gulich and Romanes, and its general application is familiar to all through the classical illustration of snails in different valleys in the Sandwich Islands given by Gulich. The influence of the other two factors the speaker has never seen

emphasized although he is inclined to believe that they are very important factors in evolution. The second factor which is a form of isolation, namely tendency to self-fertility or prepotency of pollen, would be present whenever the flowers of the plant are modified to insure self-fertilization, as in the case of the pea, bean, and many other legumes, in wheat, barley, and some other plants, and in cases which may occasionally occur where the mutation gives rise to a plant which has a strong tendency towards self-fertility, the progeny of cross fertilization with pollen of another individual being fewer in number and lacking in vigor. Such a mutation was observed and experimented with by Darwin and graphically described under the caption "The Hero Morninglory."[1] The races of Cupid sweet peas, and various wheat races are illustrations of cultivated species, we may call them, that have originated in this way. Given a mutation suited to the environment, having strong transmitting power, and a tendency to self-fertility, or some device insuring self-fertility and we have the creation of a new species.

The third means by which the swamping effect of panmixia may be overcome is where a tendency to prepotency or preponderance of type is formed. In such instances the mutation, giving rise to a type which while not necessarily preferring self-fertilization is strongly prepotent and dominant in its action and transmits its characters to all its progeny which bred *inter se*, would probably strengthen the type and lead to its gaining a permanent foothold. Such illustrations, like the Ancon or Otter sheep are not uncommon among domestic animals and plants.

*July 30.* **The General Laws of Hybrids with a Discussion of Mendel's Principles.** By HERBERT J. WEBBER.

The claim advanced by Mendel and some of his followers that of a certain allelomorph or character pair, one character is dominant and masks the other character in first generation hybrids was claimed by the speaker to have but limited application. Many cases of blends of two characters were cited. It was also pointed out that the statement that first generation hybrids are of the same type is erroneous. The case of hybrids of orange

[1] Darwin, Cross and Self-fertilization in the Vegetable Kingdom," p. 47.

(*C. aurantium*), trifoliate orange (*C. trifoliata*), where each seedling differs from every other seedling, was cited.

It was shown that the conception of purity of the germ cell which is the primary feature of Mendel's laws must certainly be modified as the fact of reversions to ancestral characters in types that have bred true for generations show that the "Analage" of the character must have remained in the germ cell through all these generations without exerting or showing itself. Cases of reversion in cotton and other plants were cited as illustrations.

The principle of the segregation of characters in the formation of the germ cells was also denied from the fact that many hybrids have been bred into fixed races coming true to seed that exhibit a heterozygote character intermediate between the two parental characters. Such races are the white cap dent corn, a hybrid of a yellow and a white dent which is yellow on the sides and white on the apex of the kernel; the Griffin, Allen hybrid, and Doughty cottons which are hybrids of sea island and upland cotton that have fibers intermediate between the two parents in length and fineness.

Mendel's researches were considered by the speaker to be of the utmost importance from the theoretical scientific standpoint, but it was claimed that they will have little or no effect in changing the methods of practical breeding.

*July 31.* **The Utilization of Hybrids in Practical Plant Breeding; and the Selection of Vegetative Parts in Breeding.** By HERBERT J. WEBBER.

While pure selection gives the quickest and surest results in breeding, it is to hybridization that we must give attention when we desire to produce striking new sorts or combinations of the good qualities of two or more existing sorts with the elimination of the undesirable features. It is very necessary to carefully select the races or species to be combined, and also just as necessary to select the best individuals of these races or species that are to be used as the parents.

The second generation is the variable hybrid generation from which our selection of desirable combinations must be made. This is in accordance with Mendel's conclusions but was known

and used in practice long before the rediscovery of Mendel's works.

The fixation of select hybrids into stable races is best accomplished by isolating the progeny of the select plant and breeding together those individuals of the progeny which are nearest alike. Probably fixity or uniformity could be gained quicker by in and in breeding, but in plants that are normally cross fertilized the loss of vigor and fertility from the inbreeding would probably in most cases render the use of this method impractical.

Attention was directed to the important improvements that can be secured by the selection of vegetative parts. By the selection of vigorous growing cuttings of the carnation, violet, rose, etc., the size and number of the flowers produced can be greatly increased. Many bud sports or bud mutations have been used as new varieties and are valuable acquisitions.

Plant breeding, it was pointed out, is not necessarily a difficult task. The speaker urged the great importance of the work and the necessity of more extensive scientific investigations and practical experiments.

*August 5.* **Cytoplasmic Structures of the Plant Cell.** By BRADLEY MOORE DAVIS.

The writer described in this seminar the principal structures and activities of the cytoplasm in different parts of the plant cell and at different periods of ontogeny. There are three principal regions of the cytoplasm: (1) The plasma membranes (kinoplasmic in character), which surround the protoplast, the vacuoles and the nucleus, (2) trophoplasm, and (3) the kinoplasm intimately concerned with mitotic phenomena and which finds morphological expression in asters, centrospheres, centrosomes and filarplasm. The structure of trophoplasm was described together with the peculiar physodes, nematoplasts and cœnocentra. But the main discussion concerned the behavior of kinoplasm during mitosis and the segmentation of the protoplasm at cell-division. Many of the kinoplasmic structures characteristic of these events may be closely related to one another, in spite of their diverse morphology, when studied ontogenetically, and the author discussed some of these problems with especial reference to his studies on the Hepaticæ and Thallophytes.

*August 6.* **Theory of the Nature of Solutions. Dissociation Hypothesis and Objections to It.** By RODNEY H. TRUE.

*August 7.* **Toxic Action of Solutions on Plants Caused by Solutions Containing One Solute.** By RODNEY H. TRUE.

*August 10.* **Toxic Action of Solutions on Plants Caused by Solutions Containing More than One Solute.** By RODNEY H. TRUE.

*August 11.* **Influence of Solutions on Plant Functions and Structure.** By RODNEY H. TRUE.

These seminars presented a discussion of the theory of electrolytic association and its bearing on plant physiology. The theory was outlined and some of the more recent objections to it were stated, together with some of the more important grounds on which such objections are based. Attention was called to the bearing of these objections, with reference to physiological research along these lines, and caution was advised in construing results in terms of the theory. It was pointed out that, as long as a considerable mass of evidence lies against this hypothesis, physiologists should not commit themselves too thoroughly to the theory and its conclusions. The toxic action of various classes of compounds was then discussed in the light of the dissociation hypothesis and the relation between physiological action and molecular structure was pointed out. Some relations obtaining between the structure and functions of plants and the action of molecules and ions was discussed.

*August 11.* **The Influence of Insoluble Substances on the Action of Poisons in Solution.** By CHRISTOPHER S. OGLEVEE.

Seedlings of *Lupinus albus* were grown in beakers containing the various poisons. The concentration which would kill the radicle was determined. It was found that finely divided particles of an insoluble substance placed in the beaker containing the poisonous solution not only allowed the radicle to grow, but often accelerated the growth above the normal, and produced effects similar to those of a more dilute solution. The insoluble substances used, sand, pounded Bohemian glass, shredded filter paper, potato starch, and paraffine, were cleaned and washed as

thoroughly as possible. Some of the poisons used were copper sulphate, silver nitrate, mercuric chloride, citric acid, resorcin, phenol, thymol, etc. The effects could not be due to the action of the insoluble particles on the ions of the poisons which do not dissociate. The variety of insoluble substances used would indicate that the effects were not due to the slight solubility which some of the particles possess. Since no other suggestion presents itself, perhaps the theory of "adsorption" offers the best explanation to the problem.

*August 12.* **Artificial Sea Water.** By RODNEY H. TRUE.

The experiments now in progress at the United States Fish Commission in connection with the attempts to make artificial sea water capable of sustaining marine life were discussed. Two sorts of solutions were compounded, one a synthetic, prepared by adding to distilled water the required salts in quantities indicated by analysis. The second solution was obtained by dissolving in distilled water a complete sea salt obtained by evaporating sea water to dryness over steam. The importance of the presence of the full amount of calcium was pointed out and the utility of charging the solutions with carbon dioxide gas was noted. The report of the results thus far obtained with the marine plants and animals indicated that the synthetic solutions are less satisfactory than those obtained from evaporated sea salt. The hope was expressed that the latter might be to a considerable degree satisfactory for the demands in this direction, but the fact that experiments thus far have covered only two summer sessions was cited as ground for a cautious interpretation of these results.

3. BOTANICAL LECTURES AND SEMINARS IN 1904.

July 12, Dr. George T. Moore: "Botanical Work at Several Botanical Laboratories in Holland, Scandinavia and Russia."

July 13, Dr. George T. Moore: "The Physiological Methods of Purifying Water Supplies."

July 15, Mr. Mintin A. Chrysler: "Regeneration in Plants as Illustrated by Zamia Floridana."

July 19, Miss Etoile B. Simons: "Morphological Studies on Sargassum Filipendula."

July 22, Dr. James J. Wolfe: "Cytological Studies on Nemalion."

July 27, Dr. Henry Kraemer: "The Origin and Nature of Color in Plants."

August 1, Dr. G. F. Blakeslee: "Sexual Reproduction of the Mucorineæ."

August 10, Dr. Bradley M. Davis: "The Algal Flora of the Bay of Naples."

*July 12.* **Botanical Work in Several Botanical Laboratories of Holland, Scandinavia and Russia.** By DR. GEORGE T. MOORE.

A popular account of a recent visit made to some of the principle botanical laboratories in the countries mentioned. A description of the facilities for work at Delft, Amsterdam, Copenhagen, Christiania, Bergen and Stockholm, with a brief reference to the principle botanists in these cities was given, as well as a more detailed account of the Institute for Experimental Medicine at St. Petersburgh and its illustrious director, Winogradsky.

*July 13.* **The Physiological Method of Purifying Water Reservoirs.** By DR. GEORGE T. MOORE.

After a brief reference to the very widespread difficulty in water supplies due to algæ, and the failure to devise any means of removing or preventing the bad odors and tastes, an account of the toxic effect of copper sulfate upon algæ was given. It has been known for a long time that many of the heavy metals were extremely poisonous to some plants, and experiments showed that copper sulfate could be used at a dilution so high as to be absolutely harmless to man and yet sufficient to destroy or prevent the growth of algal pests. Practical application of the method to reservoirs containing millions of gallons has shown that the necessary requirements of efficiency, cheapness and harmlessness to man are all complied with and it is believed that a thoroughly reliable means has been devised for preventing the growth of algæ in water supplies.

While the application of the method to the destruction of typhoid and cholera is not universal as with the algæ, it is believed that under certain conditions the use of copper sulphate

offers the only known means of thoroughly and quickly sterilizing a reservoir.

Extensive experiments on a large scale are now being carried on and results already obtained warrant the conclusion that the method is satisfactory in every respect.

*July 15.* **Regeneration in Plants as Illustrated by Zamia floridana.** By MR. MINTIN A. CHRYSLER.

*Zamia floridana* exhibits a remarkable capacity for producing new shoots and roots from pieces of stem. A piece no larger than a walnut can give rise to a new plant. The new shoots proceed in most cases from the vascular region of the central cylinder, but may arise from the neighborhood of the periderm, or may form a cap over the whole central cylinder. Only the last case merits the term "regeneration"; the others are merely instances of adventitious budding. Roots may spring from the cut surface just as do the shoots. The power of producing new shoots seems to be shared by all tissues which have remained meristematic, or which have resumed the power of cell division such as the phellogen of the wound cork. A case of budding from the hypocotyl has been observed. The theories of "latent buds" and "polarity" are not supported by the specimens of *Zamia* examined.

*July 19.* **Morphological Studies on Sargassum Filipendula.** By MISS ETOILE B. SIMONS.

The conceptacle, antheridium, oögonium, and cryptostoma were discussed in detail.

*Sargassum Filipendula* is unlike the accounts of authors who have studied various other members of the Fucales in the development of its conceptacle.

Bower in his article "On the Development of the Conceptacle in the Fucaceæ" describes a single superficial initial cell, which usually disintegrates. According to his account cells adjacent to this initial divide and form the conceptacle. Holtz announces a group of initial cells in *Pelvetia fastigiata* which disintegrate. Below these and other disintegrating cells are found the elements which form the conceptacle walls.

The conceptacle of *Sargassum* originates with a single superficial cell. Cell division beginning in this initial continues in the progeny until the conceptacle is formed. The entire organ, therefore, is the descendant of one cell, the true initial.

The antheridium and oögonium develop from wall cells of the conceptacle as in other members of this group. The oögonium has no pedicel, however, and usually contains but one egg.

The cryptostoma develops from a single superficial cell as does the conceptacle and is homologous with that organ.

*July 22.* **Cytological Studies on Nemalion.** By DR. JAMES J. WOLFE.

The chromatophore of *Nemalion* has a hollow ellipsoid form from which processes radiate to the periphery of the cell and there flatten out to form a clathrate membrane. The region surrounded by the ellipsoid portion of the chromatophore, and generally regarded as a pyrenoid, consists entirely of vacuolar material.

The sex-organs cannot be regarded as unicellular structures; since in earlier stages the trichogyne possesses a well organized nucleus, which fragments as that organ matures; the egg-cell thus becoming an intercalary cell, and the trichogyne one which has been specialized in connection with the reproductive processes.

The nucleus of the spermatium normally divides into two fertilizing elements which are discharged into the trichogyne; which events show the so-called spermatium to be an antheridium.

In the mature cystocarp the ultimate cells give rise terminally, as well as by subterminal proliferation, to a variable number of carpospores, which is further augmented by repeated proliferation within the successively formed mother-cell walls.

The entire chromatin content of the nucleus is stored in the nucleolus, and in the prophases of division passes to the nuclear wall along delicate fibrillæ. The spindle is intranuclear, and centrosomes are distinctly visible at metaphase.

The conclusion that *Nemalion* presents the essentials of an antithetic alternation of generations, and that the cystocarp is, therefore, the homologue of the sphorophyte in higher plants, is indicated by cytological evidence — since approximately sixteen chromosomes are present in the divisions of the cells of the cysto-

carp up to the period of spore formation, and approximately eight in those of the thallus, the reduction division being immediately associated with the production of carpospores.

*July 27.* **The Origin and Nature of Color in Plants.** By DR. HENRY KRAEMER.

Color in plants is due to definite constituents which either themselves are colored or they produce colors when acted upon by other substances. These constituents are either associated with some of the organized bodies of the plant cells, or they occur in the cell-sap. To the former belong the pigments associated with the etioplasts, chloroplasts and chromoplasts. These are distinguished from all other color substances of the plant by their solubility in ether, benzol, xylol, chloroform and similar solvents.

Besides the plasted pigments there are substances dissolved in the cell-sap. These occur in all parts of the plant and give rise to the other shades and tints than yellow and green. They are quite soluble, usually in a 50 per cent. hydro-alcoholic solution, and are insoluble in the above-mentioned solvents. They give well-marked reactions with certain groups of reagents and show many properties in common whether obtained from flowers, leaves, fruits, roots or stems.

The relationship of the chloroplastid to the production of starch has already been pointed out. The occurrence of proteid substances in chromoplastids suggests that they have the special function in the manufacturing or storing of nitrogenous food material which is subsequently utilized in the development of the ovule, germinating plant or biennial plant. The wide distribution of cell-sap colors, which share many general properties in common, suggests that these substances, like other unorganized cell contents, are but incidental to physiological activity.

*August 1.* **Sexual Reproduction of the Mucorineæ.** By A. F. BLAKESLEE.

According to their methods of zygospore formation the Mucorineæ may be divided into two groups. In the homothallic group zygospores are developed from branches of the same thallus. In the heterothallic group zygospores are developed from branches

which necessarily belong to thalli diverse in character. Every heterothallic species is an aggregate of two distinct strains through the interaction of which zygospore production is brought about. These sexual strains in an individual species show a more or less marked differentiation in vegetative luxuriance which may be designated by (+) and (−) signs respectively. A process of imperfect hybridization will occur between unlike strains of different species. By taking advantage of this character it has been possible to group together in two opposite series the strains of all the heterothallic species under cultivation. When thus grouped the (−) strains will be in one series while the (+) will be in the other. In the two series are represented the two sexes.

*August 8.* **The Algal Flora of the Gulf of Naples.** By DR. BRADLEY M. DAVIS.

This seminar considered the character and distribution of the marine algæ in the vicinity of Naples and was illustrated by a collection. Comparisons were made with the flora of the Atlantic coast of America south of Cape Cod which has some important features in common with the Mediterranean. The opportunities for botanical work in the zoölogical station at Naples were described.